ENGINEERING EVALUATION/COST ANALYSIS

Rainy Mine and Mill Site
Mount Baker-Snoqualmie National Forest, Washington

Prepared For:

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ACRONYMS AND ABBREVIATIONS

μg/L	Microgram per liter
bcy	Bank cubic yard
cfs	Cubic feet per second
cm/sec	Centimeter per second
gpm	Gallon per minute
lcy	Loose cubic yard
mg/L	Milligram per liter
mg/kg	Milligram per kilogram
sf	Square foot
t $CaCO_3$/kt	Ton calcium carbonate per kiloton of waste
ABA	Acid base accounting
AGP	Acid generating potential
AMSL	Above mean sea level
APA	Abbreviated Preliminary Assessment
ARAR	Applicable or Relevant and Appropriate Requirements
BMP	Best management practice
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
CES	Cascade Earth Sciences
CFR	Code of Federal Regulations
COI	Contaminant of interest
COPC	Contaminant of potential concern
COR	Contracting Officer's Representative
CPEC	Contaminant of potential ecological concern
EE/CA	Engineering Evaluation/Cost Analysis
EF	Exposure factor
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
FP S&Gs	Forest Plan Standards and Guidelines
FR	Forest Road
GCL	Geosynthetic clay liner
HDPE	High density polyethylene
HHRA	Human Health Risk Assessment
HI	Hazard index
LRMP	Land and Resource Management Plan
MDC	Maximum detected concentration
MDL	Method detection limit
MFSR	Middle Fork Snoqualmie River
MSE	Millennium Science and Engineering, Inc.
MTCA	Model Toxics Control Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFS	National Forest System
NNP	Net neutralization potential
NPR	Neutralization potential ratio
NWFP	Pacific Northwest Forest Plan
O&M	Operations and maintenance
PRG	Preliminary Remediation Goal
RAO	Removal action objective

ACRONYMS AND ABBREVIATIONS (continued)

RfD	Reference dose
RME	Reasonable maximum exposure
RTE	Rare, threatened or endangered
SHPO	State Historic Preservation Officer
SI	Site Inspection
SPLP	Synthetic precipitation leaching procedure
T&E	Threatened and endangered
TCLP	Toxicity characteristic leaching procedure
TEE	Terrestrial Ecologic Evaluation
WAC	Washington Administrative Code
WDOE	Washington Department of Ecology
WSDH	Washington State Department of Health
WRCC	Western Regional Climate Center
XRF	X-Ray fluorescence

EXECUTIVE SUMMARY

Millennium Science and Engineering, Inc. (MSE) prepared this Engineering Evaluation/Cost Analysis (EE/CA) for a proposed Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) removal action at the Rainy Mine in western Washington. This inactive copper mine is located on the Mt. Baker-Snoqualmie National Forest, about 12 miles northeast of the town of North Bend, (Figure 1). While the Site is currently inactive, several active mining claims still exist on the Site. The Site is in the Quartz Creek drainage, which is a tributary to the Taylor River and Middle Fork of the Snoqualmie River (MFSR). Sensitive ecosystems within 2 miles of the Site include jurisdictional wetlands on Quartz Creek. In addition, numerous sensitive or threatened species have potential habitat in the vicinity of the Site.

The scope of removal actions evaluated in this EE/CA focus on:

(1) Eliminating direct contact with high concentrations of metals in the waste rock, soil, and sediment for all receptors;
(2) Reducing or eliminating the migration of contaminants to the environment;
(3) Improving surface water quality; and
(4) Mitigating physical hazards at the Site.

Cascade Earth Sciences (CES) completed a Site Inspection (SI) of the Rainy Mine in 2005. The Site consists of a small concrete mill foundation, two waste rock piles, an open vertical shaft, one open adit and several apparent collapsed features. Public site use is moderate and physical hazards at the Site pose a significant public risk. The Site is adjacent to a large perennial stream (Quartz Creek) and two seeps emanating from waste rock pile WR-1, and a small unnamed ephemeral stream that flows across waste rock pile WR-2 contribute metals loading to the stream. MSE evaluated potential human health and ecological risks at the Site in 2006. The streamlined risk evaluation indicated significant potential risk to both human and ecological receptors at the Site from exposure to high concentrations of metals, particularly arsenic, in the mine waste, soil, sediment, and surface water. Maximum concentrations of arsenic in the mine waste/soil (15,800 milligrams per kilogram [mg/kg]) exceeded human and ecological screening criteria by 790 and 1,596 times; sediment (3.34 mg/kg) by 2 times (human health); and surface water (57.7 micrograms per liter [μg/L]) by 3,206 and 19 times, respectively. Risk-based cleanup levels were developed for soil and sediment in the risk evaluation using human health risk equations and site-specific exposure factors to back-calculate values based on acceptable risk levels (MSE 2006).

Mine waste and sediment at the seeps contain high concentrations of metals and are the primary contaminant sources at the Site. Fine-grained materials (i.e., sediment) that may have been deposited in, or migrated to, Quartz Creek is considered a secondary contaminant source. Surface and groundwater flowing through the mine waste are also considered secondary contaminant sources because impairments to surface water quality at the Site result from direct contact with the mine waste. Removal of the primary contaminant sources (i.e. mine waste and seep sediments) should eliminate surface water quality impairments and metals loading to Quartz Creek and significantly improve water quality. Therefore, the removal action alternatives focused on addressing the mine waste and treatment of the seeps and surface water at the Site was not included in the removal scope. Groundwater is not used for drinking water at the site and future use as a drinking source is not anticipated so treatment of groundwater was not included in the removal scope. Sediment that has migrated to Quartz Creek was also eliminated from the removal scope because it does not pose a significant human health risk, is generally consistent with background, and an in-stream removal would result in significant collateral damage to the stream channel. If future water quality monitoring indicates that a significant risk from surface water or sediment in Quartz Creek remains, additional removal actions may be necessary.

Three removal action alternatives were evaluated for the Rainy Mine:

- Alternative 1 – No Action
- Alternative 2 – Excavation and Off-site Disposal
- Alternative 3 – Excavation and On-site Disposal

Alternative 3 is recommended. Approximately 2,000 bank cubic yards (bcy) of mine waste, soil, sediment and concrete would be excavated and disposed of in an on-site repository to be constructed on a ridge above the mill site. Another 150 bcy of mine waste would be used to backfill the open shaft. The repository would be capped with an engineered low permeability cover to minimize infiltration through the waste material. The excavated waste areas would be covered with topsoil, seeded, and hydromulched. Trees and brush cleared during the removal action would be used to generate slash and cover for seeded areas. Physical hazards would be addressed by installing a bat gate in the open adit and filling the open shaft with mine waste. Approximately 20 loose cubic yards (lcy) of miscellaneous debris and litter would be removed and hauled to the nearest sanitary landfill for disposal. A temporary bridge must be erected to provide heavy equipment access to the Site. Because long-term maintenance (other than post-removal water quality monitoring) is not expected to be necessary, permanent vehicular access is not required and the bridge would be removed at completion of the removal action.

The total estimated cost for the recommended alternative is **$508,150.**

1.0 INTRODUCTION

Millennium Science and Engineering, Inc. (MSE) was contracted by the United States Department of Agriculture, Forest Service (Forest Service) to perform an Engineering Evaluation/Cost Analysis (EE/CA) for a contemplated non-time critical removal action at the Rainy Mine ("the Site") on the Mt. Baker-Snoqualmie National Forest.

- This EE/CA is being performed by the Forest Service under its cleanup authorities (42 USC 9604(a), 7 Code of Federal Regulations (CFR) 2.60(a)(39) and Federal Executive Order 12580). The purpose of this EE/CA is to select an alternative to minimize or eliminate any release or threat of release of a hazardous substance into the environment or impact on public health and welfare as outlined in 40 CFR 300.415(b)(2)(i)-(viii).
- This EE/CA was prepared utilizing the U.S. Environmental Protection Agency (EPA) *"Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA"* and in accordance with the provisions of National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR 300.415(b)(4)(i).
- The purpose of a removal action is to "abate, prevent, minimize, stabilize, mitigate or eliminate the release or the threat of a release" (40 CFR 300.415). The EE/CA for a removal action is intended to:
  - Satisfy environmental review requirements for removal actions;
  - Satisfy administrative record requirements for documentation of removal action selection; and
  - Provide a framework for evaluating and selecting alternative technologies.
- To meet those purposes, this EE/CA identifies objectives for the removal action and evaluates the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives.
- The primary sources of data used to evaluate site conditions and to develop removal action alternatives, are the Streamlined Human Health and Ecological Risk Assessment report prepared by MSE (2006), the Site Inspection (SI) report prepared by Cascade Earth Sciences (CES 2005), and the Abbreviated Preliminary Assessment (APA) prepared by the Forest Service (2003).

2.0 SITE CHARACTERIZATION

A detailed site characterization is presented in the SI (CES 2005); please refer to that report for more information. A vicinity map is provided in Figure 1, and an overall site map showing primary site features is provided in Figure 2. Site features include:

- One open vertical shaft;
- One adit and several apparent collapsed features;
- Two waste rock piles; and
- Concrete mill foundation and miscellaneous debris.

2.1 Surrounding Land Use and Populations

Land uses in areas surrounding the Site include minerals prospecting, timber harvesting, firewood cutting, and recreational activities such as hiking, swimming, camping, fishing, and hunting. While the Site is currently inactive, there are four active claims on the Site (CES 2005). Site public use is moderate and the Site is promoted in *Discovering Washington's Historic Mines* (Northwest Underground Explorations 1997). The town of North Bend is about 12 miles southwest of the Site and has approximately 4,746 inhabitants (U.S. Census Bureau 2006). There are no known residences within a 4-mile radius of the Site (CES 2005).

2.2 Data Gap Investigation

MSE conducted a reconnaissance of the Site with the Forest Service Contracting Officer's Representative (COR) on June 12, 2007. Selected photographs taken during the site reconnaissance are provided in Appendix A. The estimated waste rock and contaminated soil quantities are presented in bank cubic yards (bcy). In general, the observed Site features were consistent with descriptions presented in the SI report and APA.

- Access along Forest Road (FR) 5640 is difficult and requires a high-clearance, 4-wheel drive vehicle. The road leading from FR 5640 to the Site is heavily overgrown and blocked by a large, deep ravine that has washed out about 100 feet of road. Access by heavy equipment would require significant effort to construct a suitable road and temporary bridge across the ravine.
- The Site is located along a steep, heavily forested slope adjacent to a perennial stream at an elevation of about 1,800 feet above mean sea level (AMSL).
- Site features fall into two zones about 900 feet apart:
  - The east zone consists of the mill site, open shaft, and waste rock pile WR-1. A 70-foot caved adit reportedly located approximately 150 feet south of the shaft could not be located.
    - The volume of waste rock in pile WR-1 appears to be generally consistent with the SI report (~2,000 bcy).
    - Two seeps emanate from the toe of WR-1 and flow for approximately 100 feet before entering Quartz Creek. Quartz Creek flows into the Taylor River about 1.5 miles downstream of the Site and into the Middle Fork of the Snoqualmie River (MFSR) about 1.0 mile further downstream.
    - Flows from the two seeps were measured during the SI and the combined flows averaged less than 1 gallon per minute (gpm).
    - Quartz Creek was not wadeable because of high flows and the rate of flow was not measured; however, during the SI flows were recorded upstream and downstream of the Site at 14.1 cubic feet per second (cfs) and 16.1 cfs, respectively.
    - Surface water was also observed flowing along the access road and the top of WR-1 where it infiltrated. The source of this water was unclear but there were numerous springs emanating from the hillside above the Site, as well as several small streams. This flow likely contributes to the seeps emanating from the toe of WR-1.
  - The west zone consists of an open adit (Adit 1) and waste rock pile WR-2.
    - The volume of waste rock in pile WR-2 appears to be generally consistent with the SI report (~25 bcy). The pile blends well with the surrounding soil and it was difficult to discern between waste rock and natural soil based solely on visual observation.
    - A small pool of standing water was observed inside Adit 1; however, no discharge was observed and there was no evidence of flow from the adit.
    - Flow in an unnamed drainage adjacent to Adit 1 was measured at approximately 1 gpm during the SI. The unnamed drainage flows across the edge of waste rock pile WR-2 and into Quartz Creek. A water sample collected from this drainage downstream of waste rock pile WR-2 during the SI contained arsenic at 57.7 microgram per liter (μg/L). A water sample collected from this drainage upstream of WR-2 by MSE during the site reconnaissance contained total arsenic below the method detection limit (MDL) of 3 μg/L.
- Climate data for the Site was obtained from the Western Regional Climate Center (WRCC 2007). The nearest climate station is located at the Snoqualmie Pass, Washington monitoring station, about 12 miles southeast of the Site at an elevation of about 3,020 feet AMSL.
  - The Site, located approximately 1,200 feet lower in elevation than the monitoring station, likely receives less total precipitation and has higher minimum and maximum temperatures.
  - The climate data is summarized in Table 1.

2.3 Source, Nature and Extent of Contamination

Based on information provided in the SI, contaminants of interest (COI) at the Site include: aluminum, arsenic, barium, cadmium, copper, iron, lead, manganese, mercury, silver, and zinc. Analytical results of samples collected during the SI indicated concentrations of several COIs were above screening levels in the mine waste/soil, sediment, pore water, and surface water. The highest concentrations were found in the mine waste. The analytical results are summarized in Tables 2 through 6 and a summary of the estimated volumes of waste rock, sediment, and contaminated soil is provided in Table 7.

The mill site, waste rock pile WR-1, and shaft, are located along the north side of Quartz Creek and cover about 2.5 acres. A large perennial stream, Quartz Creek, flows adjacent to the Site along the south side of the mill site. Waste rock pile WR-2 and Adit 1 are located approximately 900 feet west of the mill site along Quartz Creek. Access is via an overgrown trail, with downed trees and rocks blocking the path. According to the SI, the entire Site encompasses about 9 acres (CES 2005).

Surface water features at the Site do not support a viable fish habitat; however, cutthroat trout, a federal species of concern, have been documented in the receiving stream (Quartz Creek), which flows adjacent to the Site.

The source, nature and extent of contamination at the Site are briefly described in the following paragraphs by media type. Refer to the SI (CES 2005) for more detailed information.

Surface Water

- A total of 10 surface water samples were collected during the SI: 4 from Quartz Creek, 2 from the Taylor River, 1 from the west seep below waste rock pile WR-1, 1 from the east seep below WR-1, 1 from an unnamed drainage downstream of WR-2, and 1 from an unnamed drainage upgradient of waste rock pile WR-1.
- The 10 samples included 2 background samples: 1 from Quartz Creek upstream of the Site, but downstream of other mining sites and associated disturbances, and 1 from an unnamed drainage upgradient of waste rock pile WR-1. Another sample intended to represent background was collected from the Taylor River, upstream of the confluence with Quartz Creek, but is not believed to be representative of the background conditions at the Site because of the significant distance from the Site and presence of other potential sources of contamination upstream in the Taylor River. Therefore, because only two samples were used to characterize background conditions at the Site, the reported background concentrations should be considered representative of "apparent background" conditions.
- Ten COIs in the seeps were elevated above apparent background levels: silver, arsenic, aluminum, barium, cadmium, copper, iron, manganese lead, and zinc.
- The seep samples had pH values ranging from 4.3 to 7.1, and hardness values ranging from 19 to 21 milligram per liter (mg/L) calcium carbonate ($CaCO_3$). Surface water samples from Quartz Creek had pH values ranging from 6.3 to 6.6, and a hardness value of 3 mg/L $CaCO_3$.
- Four COIs exceeded human health screening criteria: arsenic, copper, iron, and manganese. Arsenic exceeded human health screening criteria in all surface water samples, and iron and manganese exceeded human health screening criteria in the east seep from WR-1. Iron exceeded human health screening criteria in the west seep from WR-1.
- Nine COIs exceeded ecological screening criteria: arsenic V, barium, cadmium, copper, iron, mercury, manganese, lead, and zinc. The most notable exceedances were arsenic from the unnamed drainage after flowing over WR-2, and copper in the east seep from WR-1.
- The results for several COIs were reported as analyzed for but not detected; however, the MDLs for arsenic, beryllium, cadmium, chromium, copper, nickel, and selenium were above one or more screening criteria.

- Several COIs were also detected in the samples collected from Quartz Creek: aluminum, arsenic, copper, iron, and mercury. In general, COI concentrations in the downstream sample were consistent with apparent background levels and significantly lower than in the seep samples.
- The total combined flow from the seeps and the unnamed drainage is estimated at 1.3 gpm, which represents less than 1 percent of the total flow in Quartz Creek.
- There was no noticeable change in COI concentrations in samples from Quartz Creek upstream and downstream of the Site.

Sediment and Pore Water

- Eight sediment and six pore water and samples were collected during the SI. Single background samples of each were collected from Quartz Creek upstream of the Site; therefore, the reported background concentrations should be considered representative of "apparent background" conditions.
- Sediment samples were co-located with surface water samples and collected from two locations on the Taylor River, four locations on Quartz Creek, and from the two seeps.
  - One COI exceeded human health screening criteria in all sediment samples: arsenic. All samples exceeded the EPA Region 9 Industrial Soil Preliminary Remediation Goal (PRG) for arsenic (1.6 milligram per kilogram [mg/kg]).
  - Seven COIs exceeded one or more ecological screening criteria in all samples: silver, arsenic, cadmium, copper, mercury, lead and antimony. The most notable exceedance was copper.
  - In general, COI concentrations in the downstream sediment sample from Quartz Creek were consistent with, or only slightly above, apparent background levels.
- Pore water samples were collected from four locations on Quartz Creek and from the two seeps.
  - Seven COIs in pore water exceeded ecological screening criteria: arsenic V, beryllium, cadmium, copper, iron, lead, and zinc
  - pH values ranged from 4.6 to 6.5 with a hardness value of 3 mg/L $CaCO_3$ at all locations except seep-PW1 where the hardness was 19 mg/L $CaCO_3$.
  - In general, most COI concentrations were consistent with apparent background levels.

Groundwater

- Groundwater conditions at the Site are not well documented and no groundwater samples were collected during the SI.
- No water wells are reportedly located within a 4-mile radius of the Site.
- Groundwater pathway is considered incomplete.
- Groundwater will be addressed indirectly in the consideration of the seeps and contaminated soils.

Air

- Air quality at the Site has not been characterized and no air samples were collected during the SI. The most likely source of air contamination at the Site is windblown dust particulates from the waste rock piles.
- COI concentrations in the waste rock were all below EPA's soil screening level for inhalation of particulates (EPA 2004).
- Air pathway is considered complete but insignificant.

Mine Waste and Soil

- Two mine waste piles were identified during the SI: WR-1 and WR-2. The mine waste appears to consist primarily of waste rock excavated during underground operations.
- According to the SI, the total estimated volume of waste rock at the Site is about 2,025 bcy (CES 2005).

- Three background soil samples were collected during the SI. This is a relatively small data set for adequately characterizing background conditions at the Site; therefore, the reported background concentrations should be considered representative of "apparent background" conditions. The results indicated:
  - pH values ranged from 4.4 to 5.1.
  - Two COIs exceeded human health screening criteria: arsenic and chromium.
  - 10 COIs exceeded one or more ecological screening criteria: aluminum, arsenic, chromium, copper, mercury, lead, antimony, selenium, vanadium, and zinc. The most notable exceedances were aluminum, copper, vanadium, and zinc.
- A total of nine waste rock and soil samples were collected during the SI. The results indicated:
  - pH values ranged from 3.1 to 5.0.
  - One COI exceeded human health screening criteria: arsenic.
  - Thirteen COIs exceeded one or more ecological screening criteria: silver, aluminum, arsenic, cadmium, chromium, copper, mercury, lead, antimony, selenium, thallium, vanadium, and zinc. The most notable exceedances were silver, arsenic, copper, mercury, lead, selenium, thallium, vanadium and zinc.
- Acid-base accounting (ABA), toxicity characterization leaching procedure (TCLP), and synthetic precipitation leaching procedure (SPLP) tests were conducted on mine waste/soil samples from five areas: waste rock piles WR-1 and WR-2, and three areas around the mill foundation. The results indicated the following:
  - Acid generating potential (AGP) values ranged from 10 to 36 tons of calcium carbonate per kiloton of waste (t $CaCO_3$/Kt), and neutralization potential ratios (NPR) ranged from 0.03 to 0.1.
  - Waste rock piles WR-1 and WR-2, and soils around the mill foundation are likely to generate acid.
  - None of the samples had TCLP or SPLP results exceeding the RCRA TCLP disposal limits.

<u>Mill Foundation and Debris</u>

- There are no framed structures on site and only the concrete mill foundation remains.
- Miscellaneous litter and debris are on site, particularly around the mill site and on the steep hillside above the mill foundation.

2.4 Risk Assessment Conclusion

MSE completed a streamlined human health and ecological risk assessment of the Rainy Mine to evaluate risks associated with exposure to mining-related contaminants at the Site (MSE 2006). Analytical data and other information presented in the SI (CES 2005) were used in the risk calculations. Results of the streamlined risk assessment indicated significant potential risks to both human and ecological receptors at the Site.

2.4.1 Human Health Risk Assessment

The streamlined human health risk assessment (HHRA) indicated non-carcinogenic hazard and carcinogenic risk from exposure to metals, particularly arsenic, in mine waste, sediment, and surface water at the Site.

- Non-carcinogenic Hazard Indices (HI) ranged from 0.2 to 4 for the adult recreationalist, and from 3 to 100 for the child recreationalist. An HI greater than 1 indicates a potential health risk because the estimated contaminant intake exceeds the reference dose (RfD). The RfD is a contaminant-specific value established by the EPA that represents the exposure level above which represents potential adverse health effects. Six human health contaminants of potential concern

(COPC) were identified for non-carcinogenic risk: arsenic, cadmium, chromium, copper, iron, and manganese.
- Carcinogenic risks ranged from 9.E-06 to 8.E-04 for the adult recreationalist, and from 1.E-04 to 5.E-03 for the child recreationalist. Under CERCLA, EPA generally considers carcinogenic risks to an individual ranging from 1.E-06 to 1.E-04 to be acceptable depending on specific site and exposure characteristics (EPA 1991). Three COPCs were identified for carcinogenic risks: arsenic, cadmium, and chromium.
- The most significant exposure pathway is ingestion of and dermal contact with arsenic in the mine waste. Ingestion of surface water also poses a slight human health risk.
- Inhalation of particulates from the mine waste, and dermal contact with sediment and surface water contribute minimal risk and are insignificant pathways.

2.4.2 Ecological Risk Assessment

Results of the streamlined ecological risk assessment (ERA) indicated significant potential risk to ecological receptors, particularly rare, threatened, or endangered (RTE) ecological species that have potential habitat in vicinity of the Site.

- Several contaminants of potential ecological concern (CPEC) were identified at the Site, most notably aluminum, arsenic, copper, and iron.
- The highest risk ratios to terrestrial receptors were from exposure to the mine waste. There is also risk to aquatic receptors from exposure to CPECs in surface water and sediment, particularly from copper.
- With the possible exception of amphibian species, the risks appear to be limited to individual receptors rather than whole populations. This is because while individual receptors may be exposed to metals in mine wastes at the Site, their populations are unlikely to be significantly impacted because it is improbable that entire populations of receptors reside strictly within the site boundaries.
- Some sensitive species, such as the Oregon tailed frog or western toad, may have individual receptors that are at risk because they have much smaller home ranges and may inhabit areas around the seeps. This is critical because threatened and endangered (T&E) species are to be protected to the individual level. A biological survey should be conducted to determine whether those species are present at the Site in areas around the seeps, and whether bats inhabit the open shaft. A Forest Service Biologist should be consulted to determine whether protective measures need to be taken if these sensitive species are present on site.

2.4.3 Physical Hazards

Physical hazards at the Site include:

- One open shaft,
- One open adit,
- Miscellaneous debris, and
- Deep ravine across access road to the site.

<u>Adit</u>
- Adit 1 is located 900 feet west of the mill site (Figure 2).
    - The adit is in sound condition and is large enough for entry (approximately 5-feet wide by 7-feet high).

Shaft

- The shaft is located approximately 10 feet uphill of the mill foundation, approximately 5-feet by 5-feet and is partially open posing a fall hazard.

Miscellaneous Debris

- There is miscellaneous debris scattered at the mill site, particularly along the hillside above the shaft.
  - The debris consists primarily of scattered wooden timbers, mining debris, sheet metal, and other general litter.
  - There is a large (~5-foot diameter by 8-foot long) steel tank near the southwest edge of waste rock pile WR-1. The tank appeared to be empty during the site reconnaissance.
  - The concrete mill foundation is cut into the hillside and covers an area of about 75 square feet (sf).

Ravine

- The ravine that has washed out about 100 feet of the access road leading to the site from FR 5640 is about 30 feet deep with extremely steep slopes and poses a significant fall hazard to hikers and all-terrain vehicle (ATV).

3.0 SITE CLEANUP CRITERIA

There are two general types of cleanup criteria:

(1) Applicable or Relevant and Appropriate Requirements (ARAR), and
(2) Risk-based cleanup criteria developed from human health risk equations using acceptable risk levels and site-specific factors.

ARARs are "applicable" or "relevant and appropriate" federal and state environmental requirements. Applicable requirements include cleanup standards and other substantive requirements, criteria, or limitations promulgated under federal or state laws that apply to hazardous substances and removal actions at the Site. Relevant and appropriate requirements are not applicable to the Site but may be suitable for use because they address issues or problems sufficiently similar to those at present at the Site. In addition to ARARs, federal and state environmental and public health guidance and proposed standards that are not legally binding but may prove useful are "to be considered" standards.

Risk-based cleanup criteria are site-specific levels determined to be protective of human health based on acceptable risk levels, and site-specific contaminant concentrations, land uses, and exposure pathways. Risk-based cleanup levels were developed for soil and sediment at the Rainy Mine as part of the streamlined HHRA (MSE 2006).

The ARARs and proposed cleanup criteria for each media at the Site are discussed below and summarized in Tables 8, 9 and 10.

3.1 Applicable or Relevant and Appropriate Requirements

ARARs are "applicable" or "relevant and appropriate" federal and state environmental requirements used to:

(1) Evaluate the extent of site cleanup needed;
(2) Scope and develop removal action alternatives; and
(3) Guide the implementation and operation of the preferred alternative.

The NCP (40CFR 300.415(j)) establishes that a removal action shall "to the extent practical, considering the exigencies of the situation, attain ARARs under federal environmental or state environmental facility siting laws."

To determine whether compliance with ARARs is practicable, two factors are specified in 40 CFR 415(j):

- Urgency, and
- Scope of the removal action.
  - The scope of the removal action is often directed at minimizing and mitigating potential hazard rather than totally eliminating the hazard; even though a particular standard may be an ARAR for a particular medium, it may be outside the scope of the immediate problem the removal action is addressing.

A comprehensive list of potential ARARs generated and evaluated for the Site is presented in Appendix B. A request for any additional Washington State-specific ARARs was submitted to the WDOE during preparation of this EE/CA; however, no response was received. The ARARs were used to determine the design specifications and performance standards for the project. They are grouped as federal or State of Washington ARARs, and are identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR, and whether the ARAR is applicable, or relevant and appropriate.

- Administrative requirements are not ARARs and thus do not apply to actions conducted entirely on-site. Administrative requirements are those that involve consultation, issuance of permits, documentation, reporting, record keeping, and enforcement.
- The CERCLA program has its own set of administrative procedures, which assure proper implementation of CERCLA. The preamble to the final NCP states that the application of additional or conflicting administrative requirements could result in delay or confusion.
- Provisions of statutes or regulations that contain general goals that merely express legislative intent about desired outcomes or conditions, but are non-binding, are not ARARs. In accordance with Section 121(e) of CERCLA, no permits are required for the removal action.

Potential key chemical-, action-, and location-specific ARARs for a removal action at the Rainy Mine include, respectively:

- **Chemical-specific Water, Soil, and Sediment Quality Standards:**
  - Washington State Water Quality Standards for Surface Water (WAC Chapter 173-201A)
  - Washington State Drinking Water Standards (WAC Chapter 246-290)
  - Federal Water Quality Criteria for Surface Water (40 CFR 131.26)
  - 2007 Aquatic Life Ambient Freshwater Quality for Copper[1] (40 CFR 131.26)
  - National Toxics Rule Water Quality Standards (40 CFR 131.26)
  - Washington Model Toxics Control Act (MTCA) Industrial Soil Cleanup Levels – Human Receptors (WAC Chapter 173-340)
  - EPA PRGs for Industrial Soil (EPA 2004)
  - Washington Freshwater Sediment Management Standards (WAC Chapter 173-204)

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[1] The federal Aquatic Life Ambient Freshwater Quality Criterion for copper was revised in 2007 and is potentially relevant and applicable to the Site (EPA 2007). The 2007 copper criterion uses the Biotic Ligand Model to determine acute and chronic concentrations that are protective of aquatic organisms based on ambient conditions and site-specific factors. However, because there was insufficient data to calculate the 2007 criterion for the Site, the 2006 criterion was used.

- **Solid/Dangerous Waste (Solids) Disposal Requirements:**
  - Washington MTCA Terrestrial Ecologic Evaluation (TEE) Criteria (WAC Chapter 173-340)
  - Washington State Hazardous Waste Management Act and Dangerous Waste Regulations (WAC Chapter 173-303)
  - RCRA Hazardous Waste Management Subtitle C (40 CFR Part 261 to 279)
- **Forest Plan Standard and Guidelines (FP S&Gs):**
  - Mt. Baker Snoqualmie National Forest Land and Resource Management Plan as amended by the Pacific Northwest Forest Plan (i.e. PacFish Riparian Standards and Guidelines)

3.1.1 Water, Soil, Sediment and Pore Water Quality Standards

The surface water ARARs are based on Washington State and federal standards for the protection of aquatic life and human health and are summarized in Table 8. The values for hardness dependent metals were adjusted based on an apparent background value of 3 in the two background samples. Only a few COIs in surface water at the Site exceeded the surface water quality ARARs:

- Both seeps exceed ecological ARARs for aluminum, barium, cadmium, copper, and zinc. The eastern seep exceeded the ecological ARAR for lead and the human health ARAR for manganese. The western seep exceeded human health ARARs for arsenic and iron.
- The unnamed drainage (AWR-SW3) that flows across waste rock pile WR-2 exceeded the ecological ARARs for aluminum and copper, and the human health ARAR for arsenic.
- Quartz Creek immediately downstream of the Site (QC-SW3) exceeded ecological ARARs for aluminum and copper. Immediately upstream of the confluence with the Taylor River, Quartz Creek (QC-SW4) exceeded the ecological ARAR for copper.
- Neither sample from Taylor River exceeded the surface water quality ARARs.
- One background sample from the unnamed drainage upgradient of waste rock pile WR-1 exceeded the ecological ARAR for aluminum.
- Future sampling will be required to confirm background concentrations.

The soil ARARs are based on Washington State and federal standards for the protection of human health and the environment and are summarized in Table 9. Several COIs in the background soil and waste rock at the Site exceeded the soil quality ARARs:

- Several COIs in background soil exceeded human health or ecological ARARs:
  - Arsenic and hexavalent chromium exceeded human health ARARs.
  - Arsenic, copper, lead, antimony, selenium, vanadium, and zinc exceeded ecological ARARs.
- Several COIs in waste rock at the Site exceeded human health or ecological ARARs:
  - Arsenic exceeded the human health ARAR.
  - Silver, aluminum, arsenic, cadmium, copper, lead, antimony, selenium, thallium, and vanadium exceeded ecological ARARs.
- Future sampling will be required to confirm background concentrations and risk-based cleanup criteria.

The sediment ARARs are based on Washington State and federal standards for the protection of human health and the environment and are summarized in Table 10. Several COIs in sediment at the Site exceeded the sediment quality ARARs:

- Sediment at all sample locations, including the background, exceeded the human health ARAR for arsenic and the ecological ARAR for copper.

- Sediment at both seeps exceeded ecological ARARs for silver, arsenic, cadmium, copper, and antimony.
- Sediment at seep SS-2 also exceeded ecological ARARs for mercury and lead.
- Future sampling will be required to confirm background concentrations.

The pore water ARARs are based on Washington State and federal standards for the protection of aquatic life and are listed as ecological screening criteria in Table 6. Several COIs in pore water at the Site exceeded the pore water quality ARARs:

- Pore water at all sample locations, including background, exceeded the ARARs for beryllium and cadmium; however, most of the results were non-detect but the MDLs were above the ARARs.
- Pore water at one location on Quartz Creek (QC-PW4) exceeded the copper ARAR.
- Pore water at seep PW-1 exceeded ARARs for beryllium, cadmium, copper, iron, lead, and zinc.
- Pore water at seep PW-2 exceeded ARARs for arsenic V, beryllium, cadmium, and copper.
- Future sampling will be required to confirm background concentrations.

3.1.2 Solid/Dangerous Waste (Solids) Disposal Requirements

These ARARs set minimum functional performance standards for proper handling and disposal of solid waste; describe responsibilities of various entities; and stipulate requirements for solid waste handling facility location, design, construction, operation, and closure. All substantive requirements for closure and post-closure of limited purpose landfills (WAC 173-350-400) are potential ARARs (WAC 173-340-710[7][c]). The waste rock/soils at the Site are landfills that contain solid waste and are releasing hazardous substances above both state and federal cleanup standards.

3.1.3 Forest Plan Standard and Guidelines (FP S&Gs)

Portions of the Land and Resource Management Plan (LRMP) for Mt. Baker Snoqualmie National Forest (1990), as amended by Pacific Northwest Forest Plan (NWFP) (1994) are potentially applicable or relevant and appropriate for assessing Site remedial alternatives. The LRMP and NWFP include standards and guidelines that are potentially relevant and appropriate to actions at the Site, including activities within, or that affect Riparian Management Areas along Quartz Creek. These standards and guidelines include RF-2 through RF-7, which control the design, construction, and use of temporary and permanent roads and other modifications within Riparian Reserves; and MM-3, which controls solid waste and mine waste facilities within Riparian Reserves. Particular aspects of MM-3 that are potentially relevant and appropriate to closure of the waste rock piles at the Site include requirements for: (1) analysis based on best conventional methods; (2) designing waste facilities using best conventional techniques to ensure mass stability and prevent the release of acid or toxic materials; and (3) reclamation and monitoring waste facilities to ensure chemical and physical stability, and to meet ACS objectives.

3.2 Risk–based Cleanup Concentrations

Risk-based cleanup criteria were developed for soil and sediment at the Site as part of the streamlined HHRA and for comparison to ARARs criteria in the event the latter were not practicable considering the exigencies of the circumstances (MSE 2006). Groundwater is not used for drinking water at the Site and future use as a drinking source is not anticipated; therefore, no cleanup criteria were identified for groundwater. Cleanup criteria for soil and sediment were developed for each COPC using the human health risk equations for the most sensitive receptor (child recreationalist) under the reasonable maximum exposure (RME) scenario and site-specific exposure factors (EF). EFs are variables that determine the chronic daily intake rate, and include receptor body weight, exposure frequency and duration, averaging time, intake rates, chemical bioavailability, and other factors.

Cleanup levels for soil and sediment were established using an acceptable non-carcinogenic HI of 1.E+00 and a carcinogenic risk of 1.E-05 for the most sensitive receptor (child recreationalist) under the RME scenario (EPA 1991)[2]. The ARARs and the risk-based cleanup levels for soil and sediment are summarized in Tables 9 and 10. Typically risk-based criteria calculated for remote areas, such as the Rainy Mine, are higher than chemical-specific ARARs because of the reduced exposure frequency and duration at remote sites. For example, EPA's industrial PRGs for soil are based on an exposure frequency of 250 days per year, whereas the streamlined HHRA used an exposure frequency of 14 days for a recreationist at the Rainy Mine under the RME.

No COIs in sediment exceeded the risk-based cleanup criteria. Areas exceeding the soil risk-based cleanup levels are presented in Table 11 and summarized below.

- Arsenic concentrations in all soil samples collected from the waste rock piles exceeded the cleanup level of 33 mg/kg:
    - Samples from waste rock pile WR-1 had arsenic concentrations ranging from 49 to 222 mg/kg.
    - The single sample (WR-2-1) from waste rock pile WR-2 had an arsenic concentration of 15,800 mg/kg.
- Arsenic concentrations in sediment samples collected from both seeps exceeded the clean up level of 132 mg/kg:
    - Sediment from the west seep (SEEP-SS-1) had an arsenic concentration of 179 mg/kg.
    - Sediment from the east seep (SEEP-SS-2) had an arsenic concentration of 205 mg/kg.

Cleanup criteria for lead in soil and sediment could not be calculated using standard risk assessment algorithms because toxicological reference values (i.e. reference doses and slope factors) have not been established for lead. However, according to the risk assessment, there does not appear to be a human health risk from exposure to lead at the Site. The maximum detected lead concentration in soil at the Site (80 mg/kg) is well below Washington Department of Ecology's (WDOE) MTCA Method A Industrial Soil Cleanup Level of 1,000 mg/kg (2001), and EPA Region 9's Industrial Soil PRG of 800 mg/kg. In addition, the maximum detected lead concentration (31 mg/kg) in sediment is well below Washington's recommended freshwater sediment quality standard of 335 mg/kg (WDOE 2004).

4.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The general goal of a removal action is to protect human health and the environment by preventing or minimizing the potential release of a hazardous substance and reducing the potential for direct contact and transport of contaminants to the environment. Based on the human health and ecological risks identified at the Rainy Mine, the following non-time critical removal action objectives (RAO) were developed for the Site:

- Reduce human and wildlife exposure surface exposure to metals in the waste rock piles;
- Improve surface water quality and decrease metals loading to Quartz Creek;
- Improve public safety by addressing physical hazards at the Site; and

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[2]Washington ARARs specify 1.E-06 excess cancer risk for individual carcinogens and 1.E-05 total risk for multiple carcinogens.

- Attain ARARs to the extent practical considering the urgency of the situation and scope of the removal.

The following sections discuss the justification for a removal action at the Site, scope of the removal action, and the proposed removal action schedule.

4.1 Removal Action Justification

40 CFR 300.415(b), lists several factors to be considered in determining whether a removal action is appropriate. The factors relevant at this Site, and the conditions establishing the presence of those factors, are summarized below:

- **Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminates:**
  - The streamlined risk assessment indicated potential risk to human and ecological receptors from exposure to metals in the mine waste, surface water, and sediment.
    - The maximum detected concentration of arsenic (15,800 mg/kg) in the mine waste exceeds the human health risk-based cleanup level of 33 mg/kg by a factor of nearly 500.
    - The MDC of one metal (arsenic) in the mine waste exceeds WDOE's MTCA Method A Industrial Soil cleanup levels.
    - The MDC of 8 metals (aluminum, antimony, arsenic, copper, lead, selenium, silver, and vanadium) in the mine waste exceed WDOE's MTCA Ecological Indicator Soil Concentrations for Protection of Terrestrial Plant and Animals.
    - Metals concentrations in surface water discharging from the seeps and the unnamed drainage also exceed human health and ecological screening criteria. The seeps also contribute metals loading to Quartz Creek.
  - Land uses in areas surrounding the Site include minerals prospecting, timber harvesting, firewood cutting, and recreational activities such as hiking, swimming, camping, fishing, and hunting.
    - Since abandoned mines, especially those sites containing old structures, equipment, and mineral specimens attract these forest users, it is likely they would come into contact or potentially be exposed to high concentrations of arsenic, cadmium, chromium, copper, iron, and manganese.
    - Children's groups are known to visit the area for educational purposes.
    - The area is open to recreational use and the public is not restricted from entering the area or coming into contact with contaminated soils, rock and water at the Site.
  - Sensitive Oregon tailed frog or western toad populations are at risk because their small home ranges may include Site seep areas containing sediment and water containing high concentrations of aluminum, arsenic, copper, and iron.
  - Some impact to benthic invertebrate populations in Quartz Creek is indicated (CES 2005).
- **Actual or potential contamination of drinking water supplies or sensitive ecosystems:**
  - The seeps emanating from waste rock pile WR-1 and the unnamed drainage that flows across waste rock pile WR-2 both discharge to Quartz Creek.
  - There are no public water supplies at the Site and no drinking water wells within a 4-mile radius; however, recreationists may occasionally use water from Quartz Creek for cooking and as a drinking source.
    - Four COIs in the seeps and unnamed drainage exceeded human health screening criteria: arsenic, copper, iron, and manganese.

        - The maximum detected concentration of arsenic (57.7 μg/L) in the unnamed drainage exceeds WDOE and EPA human health screening criteria (0.018 μg/L) by a factor of more than 3,000.
    - Quartz Creek is habitat to the cutthroat trout, a federal species of concern.
        - Ten COIs in the seeps and unnamed drainage exceeded ecological screening criteria: aluminum, arsenic, barium, beryllium, cadmium, copper, iron, lead, selenium, and zinc. The maximum detected concentration of copper (2,020 μg/L) in the seep exceeds WDOE (1.86 μg/L) and EPA (1.0 μg/L) ecological screening criteria by factors of more than 1,000 and 2,000, respectively.
- **Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release:**
    - One partially buried tank was observed onsite. The tank is believed to be empty.
- **High levels of hazardous substances, pollutants, or contaminants in soils, at or near the surface that may migrate:**
    - The two waste rock piles on site contain a total of approximately 2,000 bcy.
        - The waste rock contains high concentrations of several metals.
        - Both waste rock piles are unvegetated and subject to erosion. Waste fines eroding from the piles will migrate to Quartz Creek.
        - The toe of waste rock pile WR-1 appears to be in the Quartz Creek floodplain.
- **Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released:**
    - The waste rock piles are subject to erosion during rain events and snowmelt.
    - The Site is estimated to received more than 100 inches of rain and 400 inches of snow per year.
- **Other situations or factors that may pose threats to public health or the environment:**
    - Physical hazards at the site pose a significant risk to the public and include one open shaft and one open adit.

4.2 Scope of Removal Action

The scope of removal actions evaluated in this EE/CA focus on:

1) Eliminating direct contact with high concentrations of COIs in the waste rock and soil;
2) Reducing or eliminating the migration of contaminants to the environment;
3) Improving surface water quality; and
4) Mitigating physical hazards at the Site.

The primary sources of contaminants at the Site contain high concentrations of metals and consist of the mine waste rock and fine-grained sediment at the seeps. Fine-grained material (i.e., sediment) that may have been deposited in, or migrated to Quartz Creek is considered a secondary contaminant source. Surface and groundwater flowing through the mine waste (i.e. seeps at WR-1 and unnamed drainage that flows across WR-2) are also considered secondary contaminant sources because impairments to surface water quality at the Site result from direct contact with the mine waste. The seeps and unnamed drainage are believed to have good initial water quality that is impacted by direct contact with the waste rock. A comparison of arsenic concentrations in samples from the unnamed drainage upstream and downstream of waste rock pile WR-2 supports this hypothesis. Arsenic in the downstream sample collected by CES during the SI was at a concentration of 57.7 μg/L while arsenic in the upstream sample collected by MSE during the site reconnaissance was undetectable (i.e. <3.0 μg/L).

Removal of the primary contaminant sources (i.e. mine waste and seep sediment) should eliminate surface water quality impairments and metals loading to Quartz Creek and significantly improve water quality.

Therefore, scope of this removal action focuses on addressing the mine waste, and treatment of the seeps and surface water at the Site was not included in the removal scope. Groundwater is not used for drinking water at the site and future use as a drinking source is not anticipated; therefore, treatment of groundwater is beyond the scope of this removal action. Sediment that has migrated to Quartz Creek was also eliminated from the scope of this removal action because it does not pose a significant human health risk, metals concentrations are generally consistent with background levels, and the collateral damage to the stream channel that would result from an in-stream removal action. If future water quality monitoring indicates that a significant risk from surface water or sediment in Quartz Creek remains, additional removal actions may be necessary.

Post-removal action monitoring will be required to evaluate the removal action effectiveness and compliance with the ARARs. The monitoring should include confirmation soil sampling during mine waste and contaminated soil removal, and post-removal monitoring of the aquatic habitat in Quartz Creek immediately downstream of the Site. The number and type of samples, analytical suite, MDLs, and sampling frequency should be determined in coordination with the applicable Washington State agencies.

4.3 Removal Action Schedule

The removal action is tentatively scheduled for 2009; however, the date is dependent on federal funding and may be subject to change by the Forest Service.

5.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section describes the selection of a removal action using a three–step process:

1) Identify potential removal action options and alternatives applicable to the Site and screen to eliminate ineffective or unfeasible alternatives;
2) Analyze selected removal action alternatives based on effectiveness, implementability, and cost; and
3) Identify existing data gaps that are relevant to the selected alternatives.

Removal action technologies applicable to the Site were identified based on a review of technical literature and previous experience at similar mine sites. The technologies, described in Table 12, were screened to eliminate inappropriate, ineffective, infeasible or cost prohibitive methods. In addition, technologies with unproven or uncertain performance were eliminated if they had relatively high implementation costs and/or would likely require implementation with other costly mitigation components. Technologies with uncertain or unproven performance were retained if they represented potentially cost effective mitigation and the performance can be investigated through pilot or bench scale testing. For this EE/CA, a potentially cost effective technology is one that could provide protection comparable to other standard methods utilized in mine reclamation, at a cost similar to or less than the costs of those methods. All components not screened out were retained as potential technologies that could be implemented at the Site.

The technologies were assessed relative to others in the same sub-category based on effectiveness, implementability, and cost. This allowed each technology to be assigned a relative ranking of high, medium, or low for each evaluation criterion. Table 12 summarizes the results of the removal action technology screening process, including the technologies retained for incorporation into removal action alternatives.

5.1 Identification and Screening of Removal Action Options and Alternatives

Conceptual removal alternative designs (Figures 3 through 5) were developed from the technologies that passed the screening process. Key design features are estimates only and provided for comparison purposes. The material quantities and flow rates provided in this section are estimates only and should be more accurately quantified for final design and removal action. Bulk excavated waste rock and contaminated soil quantities are presented in bcy; all other bulk material quantities are presented in loose cubic yards (lcy). The referenced figures are conceptual only.

Based on results of the removal action technology screening process, three removal action alternatives were selected for detailed analysis. The alternatives include:

- **ALTERNATIVE 1 – NO ACTION**
- **ALTERNATIVE 2 – EXCAVATION AND OFF-SITE DISPOSAL**
- **ALTERNATIVE 3 – EXCAVATION AND ON-SITE DISPOSAL**

Each alternative is discussed below.

Removal Action Elements Common to all Action Alternatives
Certain work elements would be employed and implemented regardless of the action alternative selected. These elements include: (1) improving site access, (2) addressing physical hazards at the Site, and (3) best management practices (BMP) to be implemented during on-site removal actions. Site access via FR 5640 is narrow and currently requires a high-clearance, 4-wheel drive vehicle. Some improvement will be needed to accommodate heavy equipment. The road leading from FR 5640 to the Site is very narrow and heavily overgrown; there is also a large ravine that must be crossed to reach the Site. The remains of an old bridge constructed of fallen trees currently spans the ravine; however, the remnants are structurally unstable and a temporary bridge would be required for heavy equipment to access the Site.

Physical hazards may be mitigated through institutional controls such as fencing, gating and/or signs, which limit public access, or by removal of the hazard, e.g. plugging with foam or filling the hazard. The open shaft would be filled with ~150 lcy of soil and rock from waste rock pile WR-1. Alternatively, if bats are determined to inhabit the shaft, a bat cupola would be installed over the open shaft. A bat gate would be installed in the open adit to prevent public access. The BMPs and proposed actions for each hazard are discussed below:

- **Site Access.** Minimally improving FR 5640 by removing obstructions, widening the road, and placing road base material (total of ~20 lcy of 2-inch minus material) in selected areas to minimize hazards along 2 miles of FR 5640 to the Site access road.
- **Physical Hazards.** Physical hazards at the Site are minimal. Each hazard is described below:
  - **Open Adit 1.** Installing a bat gate, shown in Figure 5, to prevent public access while maintaining potential bat habitat.
  - **Open Shaft.** Backfilling the open shaft with ~150 lcy of waste rock to fill the cavity and remove the hazard. Prior to filling, the Forest Service should determine if the shaft represents important bat habitat to be preserved. Alternatively, a bat cupola would be installed over the shaft to maintain bat habitat.
  - **Miscellaneous Debris.** Removing miscellaneous debris (including the large steel tank) and litter from the mill site and surrounding hillside and placing in an on-site repository, or transporting off site for disposal in a sanitary landfill depending on the final removal action alternative selection.
  - **Ravine Across Access Road.** Installing a barrier consisting of large boulders on the access road at the large ravine following completion of the removal action to prevent ATV and

vehicular access. A warning sign would be posted along the road approximately 100 feet from the ravine.

- **Best Management Practices.** During removal activities, BMPs will be employed to contain run-off, minimize erosion, and prevent sedimentation of Quartz Creek during the removal action. Specific BMPs will depend on the removal action selected and may include, but not be limited to: silt fencing, straw bales, check dams, temporary surface water diversions, sediment retention, and dust suppression.

ALTERNATIVE 1 – No Action

This alternative consists of no further action and leaving the Site as is:

- Waste rock would remain in its current location;
- Site safety issues (i.e. open adit, open shaft, debris, etc.) would remain as is; and
- Seeps discharging from the toe of waste rock pile WR-1 and the unnamed drainage flowing across waste rock pile WR-2 would continue contributing metals loading to Quartz Creek.

ALTERNATIVE 2 – Excavation and Off-site Disposal

This alternative involves excavating soil, waste rock, and sediment with COI concentrations above the risk-based cleanup levels, and transporting to an off-site facility for disposal. This alternative also includes demolition and off-site disposal of the concrete mill foundation. Disposal options depend on whether the waste rock and contaminated soil are considered a hazardous waste under Washington Dangerous Waste Rules (WAC Chapter 173-303). The waste rock is not a listed discarded chemical product or dangerous waste source, nor does it exhibit the characteristics of a hazardous waste. The results of all waste rock leachate samples analyzed during the SI using SPLP and TCLP were well below RCRA TCLP disposal limits. Therefore, the mine waste is not considered to be a Washington Dangerous Waste or a RCRA Hazardous Waste. The mine waste may be considered a special waste though because it poses a relatively low hazard to human health and the environment. The Roosevelt Regional private landfill in Klickitat County was contacted and confirmed that they will accept mine waste rock that passes TCLP disposal limits (Dillishaw 2008). Rabanco provides 25-ton capacity bins that they pick up and haul to a rail station for transport to the landfill. The rail station is located about 70 miles from the Site.

- Under this option, waste rock piles WR-1 and WR-2, contaminated soil around the mill foundation (S1 & S3), and contaminated sediment at the two seeps would be excavated and removed.
  - Clearing ~2,000 feet of the 15-foot-wide existing access road along the hillside.
    - Constructing a 100-ft temporary bridge for access to the Site.
    - Compacting and placing ~300 lcy of coarse road base.
    - Installing temporary erosion control BMPs.
  - Excavating waste rock, contaminated soil, and sediment with arsenic concentrations above the risk-based cleanup levels (soil = 33 mg/kg, sediment = 132 mg/kg).
    - ~2,000 bcy from waste rock pile WR-1 at the mill site.
    - ~25 bcy from waste rock pile WR-2 near Adit 1.
    - ~25 bcy of contaminated soil from around the mill foundation (including the concrete foundation).
    - ~100 bcy of sediment from the two seeps areas.
  - Using heavy equipment to demolish the concrete mill foundation.
  - Backfilling the open shaft with ~150 bcy of waste rock from WR-1.
  - Loading the remaining waste rock, contaminated soil, sediment and concrete (~2,000 bcy total) in 12-cy dump trucks and transporting to the temporary staging area for transfer to the 25-ton Rabanco bins.

- o Using a Niton X-ray fluorescence (XRF) to assist in delineating the extent of excavation and to field check removal efforts. Collecting a minimum of one composite confirmation sample from each area for verification of contaminant removal.
- o Transporting the bins to the rail station (~70 miles) for transfer to the Roosevelt Regional Landfill for disposal.
- o Grading the mill site and areas (~0.4 acre) from which waste rock and soil has been excavated to blend with the surrounding topography and promote drainage. Applying 6 to 12 inches of growth media (~130 lcy), applying fertilizer, seeding with a Forest Service approved seed mix, hydromulching, and planting tree seedlings in the mill site.
- o Reclaiming 2,000 feet of access road by ripping compacted surfaces, grading to blend with the natural hillside to the extent possible, seeding ~1 acre with a Forest Service approved seed mix and hydromulching.
- o Placing large boulders on the access road to block vehicular and ATV traffic, and posting a warning sign at the ravine.

ALTERNATIVE 3 – Excavation and On-site Disposal

This alternative involves excavating soil, waste rock, and sediment with COI concentrations above the cleanup criteria, and disposing in an on-site repository. Two repository locations and two cover options were evaluated for this alternative:

- Under this option, waste rock piles WR-1 and WR-2, contaminated soil around the mill foundation (S1 & S3), and contaminated sediment at the two seeps would be excavated and removed.
  - o Clearing 2,000 feet of the 15-foot-wide existing access road.
    - Constructing a 100-ft temporary bridge for access to the Site.
    - Compacting and placing ~300 lcy of coarse road base.
    - Installing temporary erosion control BMPs.
  - o Excavating waste rock, contaminated soil, and sediment with arsenic concentrations above the risk-based cleanup levels (soil = 33 mg/kg, sediment = 132 mg/kg).
    - ~2,000 bcy from waste rock pile WR-1 at the mill site.
    - ~25 bcy from waste rock pile WR-2 near Adit 1.
    - ~25 bcy of contaminated soil from around the mill foundation (including the concrete foundation).
    - ~100 bcy of sediment from the two seeps areas.
  - o Using heavy equipment to demolish the concrete mill foundation.
  - o Backfilling the open shaft with ~150 bcy of waste rock from WR-1.
  - o Loading the remaining waste rock, contaminated soil, sediment and concrete (~2,000 bcy total) in 12-cy dump trucks and transporting to an on-site repository. Two repository locations were evaluated and are discussed below.
  - o Using a Niton XRF to assist in delineating the extent of excavation and to field check removal efforts. Collecting a minimum of one composite confirmation sample from each area for verification of contaminant removal.
  - o Grading the areas (~0.4 acre) from which waste rock and soil has been excavated to blend with the surrounding topography and promote drainage. Applying 6 to 12 inches of growth media (~130 lcy), applying fertilizer, seeding with a Forest Service approved seed mix, hydromulching, and planting tree seedlings in the mill site.
  - o Reclaiming 2,000 feet of access road by ripping compacted surfaces, grading to blend with the natural hillside to the extent possible, seeding ~1 acre with a Forest Service approved seed mix and hydromulching.
  - o Removing the temporary bridge that was installed to access the Site.

- **Repository Option 1 – Primary Location Along Ridge:**
  Under this option, the repository would be constructed on a ridge above the Site, about 1 mile northeast of the mill site (Figure 3). This location is well above the Quartz Creek floodplain, has a slight depression, and is relatively close to the Site. With the conceptual configuration shown in Figure 3, the area can easily accommodate the estimated volume of mine waste with capacity to accommodate swell (~2,400 lcy total).
  - Clearing and grubbing the repository site (~0.3 ac) and stockpiling the woody debris. Excavating 2.3 feet of topsoil (~1,130 bcy) from the repository footprint and stockpiling for use in the repository cap and to cover the excavated waste areas and other disturbed areas.
  - Excavating a diversion channel along the uphill edge of the repository to intercept surface water run on. The earthen, V-shaped channel will be constructed with a slope of 1 to 2 percent, 1 to 2 feet deep, and 2H:1V side slopes. For cost estimation purposes, the assumed channel length is 200 feet. Riprap protection (~2 lcy) would be installed at the channel outlet to prevent erosion. Presumably, the riprap would be obtained from material screened on site.
  - Excavating a concave pit for the mine waste. Soil that is excavated will be stockpiled during construction and used for the cap.
  - Placing and compacting the waste rock, concrete, and contaminated soil and sediment in the repository in 8-inch-thick lifts to the approximate configuration shown in Figure 3. The proposed design is conceptual and the actual engineered designs may differ considerably based on site-specific conditions and constraints. However, the general design configurations and site preparation tasks described in the following bullets will likely be very similar independent of location.
  - Shaping the repository to blend with the surrounding topography. The foundation slope should not exceed 10 percent. The repository side slopes should not exceed a 3:1 horizontal to vertical (3H:1V) ratio and the top surface should be graded to minimize erosion, promote drainage, and prevent ponding on the repository surface.
  - Installing the repository cover. Two cover options were evaluated for the repository and are discussed below.
- **Repository Option 2 – Alternate Location At Mill Site:**
  Under this option, the repository would be constructed at the mill site against the base of the hillside. The repository will have a minimum available storage capacity of 2,400 lcy (estimated volume of mine waste plus 20 percent swell).
  - Clearing and grubbing the repository site (~0.3 ac) and stockpiling the woody debris. Excavating topsoil (~450 bcy) from the repository footprint and stockpiling for use in the repository cap and to cover the excavated waste areas and other disturbed areas.
  - Importing an additional 1,290 lcy of clean soil from an off-site source for use in the repository cap. Assumed to be an available source within 50 miles of the Site.
  - Excavating a diversion channel along the uphill edge of the repository to intercept surface water run on. The V-shaped channel will be constructed with a slope of 1 to 2 percent, 1 to 2 feet deep with 1H:1V side slopes, and lined with riprap erosion protection (~50 lcy). For cost estimation purposes, the assumed channel length is 400 feet. Riprap protection (~2 lcy) would also be installed at the channel outlet to prevent erosion. Presumably, the riprap would be obtained from material screened on site.
  - Excavating a shallow area for the repository base and stockpiling the excavated material for use in the cap.
  - Installing a French drain system (Figure 4) between the repository and hillside to intercept flows that may discharge as seeps from the hillside during wet conditions and divert flow around the mine waste material.
    - Excavating a 430-feet long, 2-feet deep and 2-feet wide trench between the repository and hillside, lining the trench with 40-mil HDPE, placing a 6-inch layer of coarse drain rock (1 to 2 inch minus) in the trench bottom, installing a 6-inch diameter perforated

drain pipe in the trench and filling with coarse drain rock (1 to 2 inch minus). The trench and pipe would be sloped at a minimum of 2 percent and routed around the ends of repository to discharge below the existing bench. Riprap erosion protection (~2 lcy) would be placed at the outlet to prevent erosion.

- Construction of the drain would proceed in lifts coordinating with placing of the mine waste. A minimum 12-inch-thick layer of coarse drain rock (1 to 2 inch minus) would be placed between the mine waste and hillside, with a layer of filter fabric (~1,500 square yards [sy]) between the hillside and drain rock, and a layer of 40-mil HDPE (~1,500 sy) between the drain rock and mine waste.
- Presumably, all drain rock (~500 lcy) would be obtained from on off-site source within 50 miles of the Site.

- Placing and compacting the waste rock, concrete, and contaminated soil and sediment in the repository in 8-inch-thick lifts to the approximate configuration shown on Figure 4. The proposed design is conceptual and the actual engineered design may differ considerably based on site-specific conditions and constraints. Before commencing final design, the site should be inspected and additional information gathered regarding the suitability of the proposed site. However, the general design configuration and site preparation tasks described in the following bullets will likely be very similar independent of location.
- Shaping the repository to blend with the surrounding topography. The foundation slope should not exceed 10 percent. The repository side slopes should not exceed a 3:1 horizontal to vertical (3H:1V) ratio and the top surface should be graded to minimize erosion, promote drainage, and prevent ponding on the repository surface.
- Installing the repository cover. Two cover alternatives were evaluated for the repository and are discussed below.

- **Repository Cover Options**
  Two cover options were evaluated for the mine waste repository and are discussed below. Repository cover material quantities will differ depending on the repository location, and cover options selected.
  - **Option 1 – Engineered Cover:**
    Consists of a geosynthetic membrane sandwiched between a 12-inch-thick fine bedding layer and a 6-inch-thick drainage layer, overlain by 2 feet of well-graded soil (Figure 3).
    - Generating ~820 lcy of fine bedding material on site by screening the mine waste and contaminated soil. Placing and compacting the screened fines over the waste material in one 12-inch lift.
    - Installing ~2,450 sy of geosynthetic membrane (geosynthetic clay liner [GCL] or high density polyethylene [HDPE] liner) over the bedding layer and testing per the manufacturer's specifications.
    - Carefully placing a 6-inch-thick drainage layer (~410 lcy) over the GCL in one loose lift.
    - Placing a single layer of filter fabric (~2,450 sy) over the drainage layer to prevent piping of fines from the cover soil into the coarse material.
    - Placing a 24-inch-thick, well-graded soil cover (~1,640 lcy) over the filter fabric in one lightly compacted 12-inch lift and one loose 12-inch lift. Adding soil amendments and seeding the cover with a Forest Service approved seed mix and hydromulching (~0.5 ac).
    - Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.
  - **Option 2 – Earthen Clay Cover:**
    Consists of a 12-inch-thick earthen clay liner overlain with a 6-inch-thick drainage layer and 24 inches of well-graded soil (Figure 3).
    - Placing ~820 lcy of clay material over the waste material and compacting in two 6 inch-thick lifts to achieve a permeability of less than 1×10^{-6} centimeters per second (cm/sec).

- Carefully placing a 6-inch-thick drainage layer (~410 lcy) over the compacted clay in one loose lift.
- Placing a single layer of filter fabric (~2,450 sy) over the drainage layer to prevent piping of fines from the cover soil into the coarse material.
- Placing a 24-inch-thick, well-graded soil cover (~1,640 lcy) over the filter fabric in one lightly compacted 12-inch lift and one loose 12-inch lift. Adding soil amendments and seeding the cover with a Forest Service approved seed mix and hydromulching (~0.5 ac).
- Placing woody debris generated during the removal action over the final cover surface to prevent erosion and provide natural habitat.

5.2 Analysis of Selected Removal Action Alternatives

The removal action alternatives were evaluated based on the following criteria:

- Effectiveness
- Implementability
- Relative cost

Effectiveness is defined as the ability of an alternative (relative to other options in the same technology sub-category) to:

- Protect public health and the community, protect workers during implementation, and protect the environment – addresses whether or not the remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls; and
- Comply with ARARs – addresses whether or not a remedy will meet all ARARs or other federal and state environmental statutes and/or provide grounds for invoking a waiver.

Implementability encompasses the technical and administrative feasibility of implementing a removal action and the availability of resources needed to implement the removal action. It also takes into account legal considerations. Factors of particular consideration include removal action and operational feasibility; availability of equipment, personnel, and treatment capacity; community acceptance; and the ability to obtain necessary permits for off-site actions.

- Technical feasibility – refers to construction and operational considerations, the demonstrated performance and useful life, adaptability to site-specific environmental conditions, whether it contributes to remedial performance, and whether it can be implemented within 1 year[3].
- Administrative feasibility – refers to the permits required, easements or right-of-ways required, impacts on adjoining properties, the ability to implement institutional controls, and the likelihood of obtaining an exemption from statutory limits, if needed.
- Availability – includes the availability of equipment, personnel and services, outside laboratory testing services (if needed), off-site treatment and disposal capacity (if needed).

[3] The ability to be implemented in 1 year is a specific criterion to be used in the alternative comparative analysis as outlined in EPA's "Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA" (1993). There is a 1-year statutory limit for fund-financed removal actions.

The relative cost of each alternative was evaluated based on professional experience, engineering judgment, and standard cost estimating tools. Primary cost considerations include:

- Capital costs,
- Engineering and design costs, and
- Operation and maintenance (O&M) costs.

The estimated costs for each task are provided in Appendix C and summarized in Table 13. Costs are based on experience at similar sites, on published data and reports, and on inquiries to possible vendors. Many removal action unit costs were obtained from R.S. Means data, and include overhead and profit (2005). Estimated costs relied on several significant assumptions regarding site conditions and are based on conceptual design only. The estimated costs are intended for alternative comparison only and are not suitable for construction bidding purposes.

Assumptions made in preparing the cost estimate include:

- All removal actions can be completed in one field season using standard removal action equipment.
- All borrow soil for covering the repository and excavated waste areas will be available either (1) from within the repository footprint, or (2) from a nearby (within 50 miles) off-site source.
- Significant cost savings may be realized from using a suitable on-site borrow source for growth medium and other materials.
- The coarse drainage material, riprap, clay material, and additional needed soil will be available and purchased from a nearby (within 50 miles) off-site source and transported to the Site.
- A temporary staging area can be established at the intersection of County Road 56 and FR 5640 for offloading equipment and materials. This will enable the use of smaller equipment at the Site and lessen the degree of required improvements to FR 5640.
- Improvements to FR 5640 will be minimal to accommodate site access.
- Improvements to the site access road will require using special construction methods and a temporary bridge to cross the ravine.
- The mine waste and contaminated soil will be screened on site to provide the fine bedding materials needed in the repository cover.
- The proposed locations for the repository are suitable and accessible, and will not require significant modification.
- The concrete mill foundation and site debris are non-hazardous and can be disposed of in a sanitary landfill.
- The Forest Service and State Historic Preservation Officer (SHPO) will approve demolition of the concrete mill foundation and the Forest Service will confirm approval for backfilling the open shaft.
- All trees and brush felled during the removal action will be stockpiled and placed over the seeded areas to minimize erosion, or burned on site.
- Post-removal monitoring costs are based on biannual site visits for a 3-year period following completion of removal action.
- Post-removal monitoring will be limited to the aquatic habitat in Quartz Creek and consist of surface water, pore water, sediment, and benthic macroinvertebrate samples from three locations on Quartz creek. The analytical suite will be limited to a select set of metals based on samples results from the SI.
- Data collected during the SI will be used as the baseline for post-removal monitoring and a pre-removal monitoring event will not be required.

- The estimated fees for removal action design and work plan preparation were based on the removal action cost for each task and ranged from 10 to 15 percent depending on the complexity of the removal action.
- The estimated fees for removal action oversight were based on the anticipated duration of the removal action and ranged from $40,000 to $60,000.
- The total estimated removal action costs include a 20 percent contingency.
- Present value corrections were not calculated because of the short duration of the removal action and monitoring.

5.3 Identification of Data Gaps

Several data gaps were identified during the preparation of this EE/CA, including:

- Lack of sufficient background samples to develop reasonably accurate average background COI concentrations for all media;
- Concrete mill foundation not characterized;
- Potential presence of T&E amphibian species in areas around the seeps and unnamed drainage at the Site, and bat species in the open shaft and adit; and
- Minimal topographical data for the Site, particularly the area between the mill site and Adit 1, and at the primary and alternate mine waste repository locations.

The data gaps, potential issues, recommended actions, and estimated costs are summarized in Table 14. Broad assumptions regarding material quantities and site conditions were used to address the data gaps in the development of conceptual designs presented in this EE/CA. However, additional data that is critical to the removal action should be collected before preparing the final design.

6.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The removal action alternatives were compared based on the following criteria:

- **Effectiveness**
  - Protective of human health and the environment
  - Complies with ARARs, especially key ARARs identified for the Site
  - Achieves RAOs
- **Implementability**
  - Technical Feasibility
  - Administrative Feasibility
  - Availability of Resources
- **Cost**

The comparative analysis of removal action alternatives is described in Table 15 and summarized below by criteria. An anticipated level of state and community acceptance is presented for each alternative; actual acceptance will be determined during the public comment period. Physical hazards were assumed to be equally addressed in all of the action alternatives as discussed in Section 5.1.

Effectiveness

- Alternative 1 – No Action is the least effective.
  - The mine waste and physical hazards would continue to pose a significant threat to public visiting the Site.
  - The mine waste and seeps would also continue to pose a threat to ecological receptors and continue contributing metals loading to Quartz Creek and the Taylor and Snoqualmie Rivers.

- Not protective of human health and the environment, and would not comply with ARARs or achieve any RAOs.

- Alternative 2 – Off-site Disposal provides the most protection to human health and the environment by removing the mine waste from the Site and disposing of in a controlled facility.
  - Most RAOs would be achieved under this alternative by removing mine waste from the Site.
  - Removal criteria are protective of human health.
  - Most key chemical-specific ARARs would be attained:
    - Surface Water Quality ARARs – It is anticipated that chemical-specific ARARs (Table 10) would be attained after removal and isolation of the waste rock that is leaching contaminants into the water. Post-removal monitoring would determine compliance success.
    - Soil Quality ARARs – Soils would be cleaned up to risk-based cleanup levels, apparent background levels, or to the lowest MTCA criteria (Table 9), whichever is greater.
    - Sediment Quality ARARs – Sediment in Quartz Creek contain metals concentrations that may slightly exceed ARARs (i.e., background levels). Stream sediments would not be addressed to avoid excessive collateral environmental impacts (see Section 4.2). Most seep-associated sediment would be removed with the waste rock and soils. Some remaining seep sediment may exceed MTCA ecological criteria for arsenic, cadmium, and copper (Table 10).
  - Compliance with Solids Disposal ARARs – Key action-specific ARARs would be attained. Contaminated wastes would be isolated from the environment in off-Site permitted waste facilities.
  - Compliance with FP S&G ARARs – Key location-specific ARARs would be attained. Wastes would be removed from and stored outside the Riparian Reserve; roads and disturbance in the Riparian Reserve would be minimized.
  - High short-term and long-term effectiveness and permanence (see Table 15).
  - Minimal potential risk to human health and the environment during off-site transportation of mine waste.
  - No reduction in toxicity or volume through treatment, but moderate to high reduction in toxicity through containment and capping.
- Alternative 3 – On-site Disposal is moderate to highly protective of the human health and environment.
  - Most RAOs would be achieved under this alternative by containing and capping mine waste.
  - Most key chemical-specific ARARs will be attained:
    - Surface Water Quality ARARs – It is anticipated that chemical-specific ARARs (Table 10) would be attained after removal and isolation of the waste rock that is leaching contaminants into the water. Post-removal monitoring would determine compliance success.
    - Soil Quality ARARs – Soils would be cleaned up to apparent background levels, risk-based cleanup levels, or the lowest MTCA criteria (Table 9), whichever is greater.
    - Sediment Quality ARARs – Sediment in Quartz Creek contain concentrations that may slightly exceed ARARs (i.e., background levels). Stream sediments would not be addressed to avoid excessive collateral environmental impacts (see Section 4.2). Most seep-associated sediment would be removed with the waste rock and soils. Some remaining seep sediment may exceed MTCA ecological criteria for arsenic, cadmium, and copper (Table 10).
  - Compliance with Solids Disposal ARARs – Key action-specific ARARs would be attained. Contaminated wastes would be isolated from the environment in an earthen repository.
    - Repository option 1 (ridge) would be more effective than option 2 (mill site) and better comply with FP S&Gs because the mine waste would be relocated to an area above the 500-year (as well as the 100-year) Quartz Creek flood elevation and out of the Riparian Habitat Conservation Area. Option 1 may also provide a more stable configuration because of the concave base.

- Repository option 1 may be subject to more potential vandalism and require more maintenance because it would be visible from FR 5640.
- Repository option 2 (mill site) would be more difficult to construct because the area is prone to storm water run on and seepage along the hillside. This option would require a drainage system and O&M to prevent clogging.
- Cover option 1 (engineered cover) would be slightly more effective than option 2 (earthen clay cover) in reducing infiltration through the waste material. Option 1 meets the substantive Solids Disposal ARARs by capping them in accordance with state landfill standards (WAC 173-350-400). The cap would consist of 2 feet of soil and a geomembrane (the presumptive cover prescribed by state regulations). Option 2 may meet ARARs if analyses during removal design indicate the alternative cover would satisfy performance standards in the regulations (WAC 173-350-400(3)(e)(I)).

  - Compliance with FP S&G ARARs – Key location-specific ARARs would be attained. Wastes would be removed from and stored outside the Riparian Reserve; roads and disturbance in the Riparian Reserve would be minimized.
  - Moderate short-term effectiveness and high long-term effectiveness and permanence (see Table 15).
  - No reduction in toxicity or volume through treatment, but moderate to high reduction in toxicity through containment and capping.

Implementability

- Alternative 1 – No Action is most technically feasible and easiest to implement; however, state and community acceptance would likely be minimal.
- Alternative 2 – Off-site Disposal would be moderately to highly implementable.
  - The availability of service and materials is high.
- Alternative 3 – On-site Disposal is moderately to highly implementable.
  - The availability of service and materials is high.
  - All options are implementable using standard construction equipment and methods.
  - Repository option 1 (ridge) would be slightly more difficult to implement than option 2 because of the additional access road improvements and site clearing required; however, option 2 would require importing ~1,290 lcy of soil from an off-site source unless a nearby borrow source could be identified.
  - Both cover options are easily implementable and agency and community acceptance should be relatively equal.

Cost

- Alternative 1 – No Action is the least expensive alternative.
- Alternative 2 – Off-site Disposal is highly expensive.
- Alternative 3 – On-site Disposal is moderately to highly expensive.
  - Repository location option 2 (mill site) would be more expensive than option 1 (ridge) because of the added cost of importing soil; however, some cost savings may be recognized by finding an nearby borrow source.
  - Cover option 2 (earthen clay cover) would be more expensive than option 1 (engineered cover) because of the cost of importing clay material and the compaction requirements.

7.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Key features of the recommended removal action alternative are discussed below. Details are provided in Section 6.2 and on Figures 3 through 5. The recommendation expressed here is based on the analysis discussed in Sections 6.3 and 7.0, and summarized in Table 8. The recommended alternative is Alternative 3 with the options listed below:

- **Alternative 3 – Excavation and On-site Disposal**
  - Repository Location Option 1: Ridge Location
  - Cover Option 1: Engineered Cover

A temporary bridge would be installed across the ravine to provide heavy equipment access to the Site. Physical hazards would be mitigated as described in Section 5.1 under Removal Action Elements Common to All Removal Action Alternatives. Mine waste, contaminated soil and sediment with contaminant concentrations above the risk-based cleanup levels would be removed and disposed of in a repository to be located on the ridge above the Site along FR 5640. Water quality in the seeps and unnamed drainage should significantly improve once the waste rock is removed; therefore, treating surface water and groundwater was excluded from the scope of this removal action.

Specifics of the recommended removal action alternative are described below:

- **Excavation and On-site Disposal:**
  - Excavating ~2,000 bcy of waste rock from WR-1.
  - Excavating ~25 bcy of waste rock from WR-2.
  - Excavating ~25 by of contaminated soil from around the mill foundation (including the concrete foundation) and demolishing the foundation.
  - Excavating ~100 bcy of contaminated sediment from the two seeps at the mill site.
  - Using a Niton XRF to assist in delineating the extent of excavation and to field check removal efforts. Collecting a minimum of one composite confirmation sample from each area for verification of contaminant removal.
  - Backfilling the open shaft with ~150 bcy of mine waste from WR-1.
  - Preparing a repository on the ridge above the Site along FR 5640.
  - Transporting the remaining waste (~2,000 bcy) to the repository and placing the material in the repository in 8-inch compacted lifts.
  - Constructing an engineered cover over the repository consisting of:
    - Screening the mine waste and contaminated soil to generate fine bedding material (~500 lcy). Placing and compacting the screened fines over the waste material in one 12-inch lift.
    - Installing a GCL (~1,500 sy) over the bedding layer and testing per the manufacturer's specifications.
    - Carefully placing a 6-inch-thick drainage layer (~250 lcy) over the GCL in one loose lift.
    - Laying a single layer of filter fabric (~1,500 sy) over the drainage layer to prevent piping of fines from the cover soil into the coarse material.
    - Placing 24 inches of well-graded soil (~1,000 lcy) over the filter fabric in one lightly compacted 12-inch lift and one loose 12-inch lift.
    - Adding soil amendments and seeding with a Forest Service approved seed mix and hydromulching (~0.3 ac).
  - Excavating a diversion channel along the uphill edge of the repository to intercept surface water run on. The earthen, V-shaped channel will be constructed with a slope of 1 to 2 percent, 1 to 2 feet deep, and 2H:1V side slopes. For cost estimation purposes, the assumed channel length is 200 feet. Riprap protection (~2 lcy) would be installed at the channel outlet to prevent erosion. Presumably, the riprap would be obtained from material screened on site.
  - Grading the areas (0.5 ac) from which waste rock and soil was excavated to blend with the surrounding topography and promote drainage. Covering disturbed areas with 6 to 12 inches of topsoil (~130 lcy), applying fertilizer, seeding with a Forest Service approved seed mix, hydromulching, and planting tree seedlings in the mill site.

- o Placing woody debris generated during the removal action over the reclaimed areas and repository cover to prevent erosion and provide natural habitat.

The recommended alternative would dispose of a total of ~2,150 bcy of waste rock, concrete, and contaminated soil and sediment. The removal action would achieve RAOs and attain ARARs to the extent practical by eliminating the surface exposure pathway to mine waste, improving surface water quality and reducing contaminant loading to Quartz Creek, and mitigating physical hazards at the Site. The recommended alternative would eliminate human health risk from exposure to the mine waste by removing waste material with contaminant concentrations above the risk-based cleanup levels.

The recommended alternative will satisfy the eight factors in 40 CFR 300.415(b) as described below.

Factor	Site Condition	Satisfied?
(1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants	Public access to contaminated soil and waste rock will be eliminated by removing the source. Overall surface water quality at the Site should improve significantly following removal of the primary waste source.	Yes
(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems	There is no public water supply and, although water discharging from seeps exceeds ARAR-based criteria, there is no measurable impact to Quartz Creek. The seeps water quality will be improved by preventing contact with mine wastes and promoting suspended solids removal.	Yes
(3) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release	One, (presumed empty) storage tank is near the mill site. The tank will be removed and transported to an off-site facility for disposal.	Yes
(4) High levels of hazardous substances, pollutants, or contaminants in soils largely at, or near, the surface that may migrate	Contaminated soil and waste rock will be removed.	Yes
(5) Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released	The waste rock and contaminated soils will be removed.	Yes
(6) Threat of fire or explosion	No flammable materials on site	Yes
(7) The availability of other appropriate federal or state response mechanisms to respond to the release	The Site is on Forest Service land and is being addressed by the Forest Service.	Yes
(8) Other situations or factors that may pose threats to public health or the environment	Physical hazards will be mitigated.	Yes

The total estimated removal action cost is **$508,150.**

8.0 FOREST SERVICE DISCLAIMER

This abandoned mine/mill site was created under the General Mining Law of 1872 and is located solely on National Forest System (NFS) lands administered by the Forest Service. The Forest Service has conducted a PRP search relating to this Site and has been unable to identify any current claimants or viable PRPs at this time. The United States has taken the position and courts have held that the United States is not liable as an "owner" under CERCLA Section 107 for mine contamination left behind on NFS lands by miners operating under the 1872 Mining Law. Therefore, Forest Service believes that this Site should not be considered a "federal facility" within the meaning of CERCLA Section 120 and should not be listed on the Federal Agency Hazardous Waste Compliance Docket. Instead, this Site should be included on EPA's CERCLIS database. Consistent with the June 24, 2003 OECA/FFEO "Policy on Listing Mixed Ownership Mine or Mill Sites Created as a Result of the General Mining Law of 1872 on the Federal Agency Hazardous Waste Compliance Docket," we respectfully request that the EPA

Regional Docket Coordinator consult with the Forest Service and EPA Headquarters before making a determination to include this Site on the Federal Agency Hazardous Waste Compliance Docket.

The proposed removal action designs presented in this EE/CA are conceptual only and not intended for removal action. All material quantities are estimates only and should be verified for final design.

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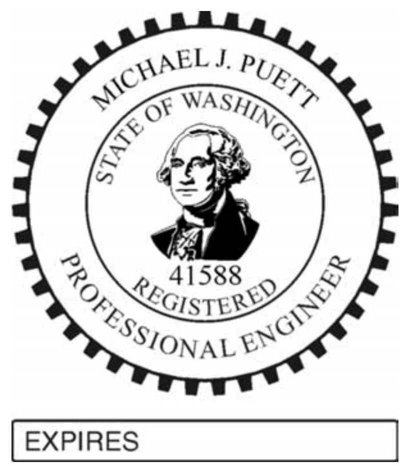

REFERENCES

Cascade Earth Sciences 2005. "Site Inspection Report, Rainy Mine, Mt. Baker-Snoqualmie National Forest." Prepared for the Forest Service. July.

Dillishaw, Theresa 2008. Personnel communication. Roosevelt Regional Landfill/Rabanco.

Millennium Science and Engineering, Inc. 2006. "Streamlined Human Health and Ecological Risk Assessment, Rainy Mine and Mill Site, Mt. Baker-Snoqualmie National Forest." Prepared for the Forest Service. May.

National Oceanic and Atmospheric Administration (NOAA). 1999. Screening Quick Reference Tables for Organics. Updated September.

Northwest Underground Explorations 1997. "Discovering Washington's Historic Mines, Volume 1: The West Central Cascade Mountains." Oso Publishing. Arlington, WA

R.S. Means 2005. *Environmental Remediation Cost Data – Unit Price.* Reed Construction Data, Kingston, Mass. 11th Annual Edition.

U.S. Census Bureau 2006. 2006 Population Estimate for North Bend, Washington. Online address: http://factfinder.census.gov/servlet/SAFFPopulation?_event=Search&_name=index&_state=04000US53&_county=index&_cityTown=index&_zip=&_sse=on&_lang=en&pctxt=fph

U.S. Department of Agriculture, Forest Service (Forest Service) 1990. Land and Resource Management Plan (LRMP). Mt. Baker-Snoqualmie National Forest. R6-MBS-004-1990. U.S. Government Printing Office.

Forest Service 1994. Northwest Forest Plan (NWFP). Online address: www.fs.fed.us/r6/nwfp.htm

Forest Service 2003. "Abbreviated Preliminary Assessment, Rainy Mine and Mill Site, Mt. Baker-Snoqualmie National Forest." September.

U.S. Environmental Protection Agency (EPA). 1991. "Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)." Interim. EPA Publication 9285.7-01B. EPA Office of Emergency and Remedial Response. Washington, DC.

EPA 1993. "Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA." EPA/540/F-94-009. Washington, D.C.

EPA 2000. "Mine Waste Technology Program Annual Report 2000." EPA Office of Research and Development, Cincinnati, Ohio.

EPA.2004. "Region 9 Preliminary Remediation Goals, Intercalc Tables." Online address: http://www.epa.gov/region09/waste/sfund/prg/

EPA.2005. "Ecological Soil Screening Levels (ECO-SSL)." Online address: http://www.epa.gov/ecotox/ecossl/

EPA.2006. "National Recommended Water Quality Criteria." EPA Office of water. Online address: http://www.epa.gov/waterscience/criteria/wqcriteria.html

EPA 2007. "Aquatic Life Ambient Freshwater Quality Criteria – Copper." EPA-822R-07-001. February.

Washington Department of Ecology (WDOE 2001a). "Model Toxics Control Act Cleanup (MTCA) Regulation." WAC Chapter 173-340-900, Table 745-1, Method A Soil Cleanup Levels for Industrial Properties. Amended February.

WDOE 2001b. "MTCA Regulation." WAC Chapter 173-340-900, Table 749-3, Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals. Amended February.

WDOE 2003. "Water Quality Standards for Surface Waters of the State of Washington." Chapter 173-201A WAC. Amended July 1, 2003. Online address: http://www.ecy.wa.gov/pubs/wac173201a.pdf.

WDOE 2004. "Freshwater Sediment Quality Standards." WAC Chapter 173-204.

Washington State Department of Health (WSDH) 2006. "Drinking Water Maximum Contaminant Levels," WAC 246-290-310. Online address: http://apps.leg.wa.gov/WAC/default.aspx?cite=246-290-310

Western Regional Climate Center (WRCC) 2007. Washington Climate Summaries. http://www.wrcc.dri.edu/summary/climsmwa.html (and linked pages), Desert Research Institute, Reno, Nevada.

Tables

Figures